BIRDS AND BIOGEOGRAPHY OF THE SIERRA DE TAMAULIPAS, AN ISOLATED PINE-OAK HABITAT

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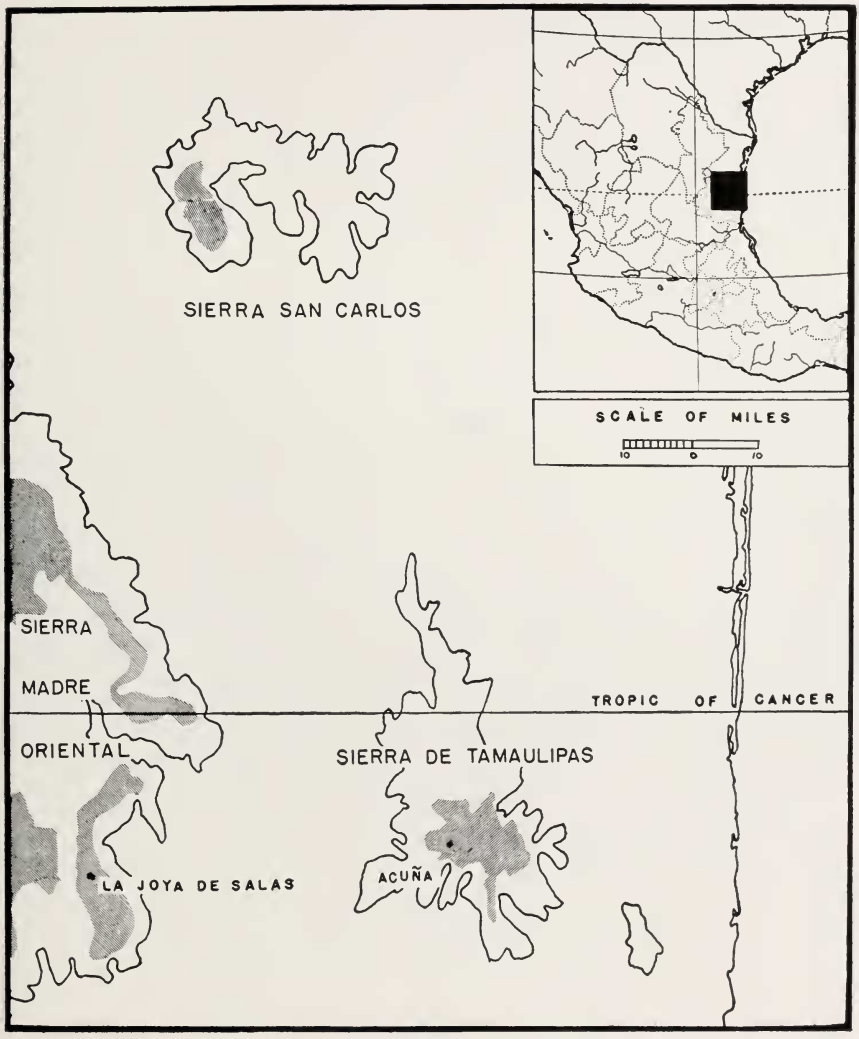
NUMEROUS distributional accounts of Mexican animals have appeared in recent years, amplifying our understanding of a rich, complex, and highly diverse fauna. Few studies, however, have related local faunas to climatic and vegetation types as outlined by Leopold (1950). By the focusing of study on a single plant formation or vegetation type, rather than on a political or other nonenvironmental unit, certain zoogeographic problems, such as Pleistocene influences on distribution patterns, are opened to investigation. The following account illustrates an application of this viewpoint.

In northeastern Mexico two small ranges, the Sierra San Carlos and Sierra de Tamaulipas, rise from the Tamaulipan Coastal Plain, completely isolated from the abrupt escarpment of the Sierra Madre Oriental. The higher parts of these ranges are covered by belts of open pine-oak woods, similar in structure and presumably in climate, to extensive forests of this nature in the adjacent Sierra Madre. They are isolated from the latter and from each other by the arid tropical thorn forest and thorn scrub of the intervening coastal plain (map 1), and thus constitute environmental islands for species inhabiting the pine-oak formation.

The coastal plain Sierras have been visited by comparatively few collectors and no faunal reports have appeared beyond that of Dice (1937) and others on the Sierra San Carlos. The pine-oak avifauna of the Sierra Madre Oriental in northeastern Mexico is somewhat better known and appears fairly homogeneous, judging from published accounts (Burleigh and Lowery, 1942; Harrell, MS; Phillips, 1911; Robins and Heed, 1951; Sutton and Burleigh, 1939; Sutton and Pettingill, 1943; Sutton, Pettingill, and Lea, 1942). Our preliminary faunal survey of the Sierra de Tamaulipas has been compared with these in viewing the relationships between the pine-oak areas of northeastern Mexico.

ACKNOWLEDGMENTS

We are indebted to the following museum curators for use of collections in their care: J. Van Tyne and R. W. Storer of the University of Michigan; K. C. Parkes of Cornell University; H. Friedmann of the U. S. National Museum; J. W. Aldrich of the U. S. Fish and Wildlife Service; Dean Amadon of the American Museum of Natural History; D. W. Warner of the Minnesota Museum of Natural History. Officials of the Direccion General Forestal y de Caza in Mexico City generously supplied collecting permits. In the course of our field work, we were aided considerably by Clinton Murchison and Howard



Map 1. Distribution of the pine-oak belt (shaded) within the 2000 foot contour (outlined) in southern Tamaulipas. Contour interval from World Aeronautical Chart 522 and 589.

Reed at the Hacienda Acuña, by Sr. and Sra. Raul Sanchez of Santa María and by Mr. and Mrs. Irby Davis. For certain plant identifications we thank Robert T. Clausen. The following individuals have examined part or all of the manuscript and offered valuable suggestions: R. T. Clausen, P. Dansereau, L. R. Dice, E. P. Edwards, B. E. Harrell, K. C. Parkes, R. W. Storer, and C.

F. Walker. For invaluable assistance, guidance, and enthusiasm we are especially indebted to George M. Sutton.

Itinerary

We entered the Sierra de Tamaulipas on April 9, 1949, traveling from the lowlands near Gonzales north to the Hacienda Acuña (elev. 962 meters; for this and other localities mentioned see the American Geographical Society millionth map N.F. 14, San Luis Potosí). About four miles northwest of Acuña at a slightly higher elevation we camped along a small stream in the pine-oak woods, collecting there until April 25. We did not return to the Sierra de Tamaulipas until June 2 when we remained until June 11, completing observations on nesting birds. In 1950, Marian and Paul Martin spent August 5 to 12 collecting mammals and reptiles at the village of Santa María (870 meters), a few miles east of Acuña. At least two other field parties including Starker Leopold and Helmuth O. Wagner in one and Chester Lamb in the other visited Acuña prior to our trip; we have no detailed information on their discoveries.

Geology

Rising from the Gulf Coastal Plain north of the Tampico Embayment, the Sierra de Tamaulipas extends along a north-south axis for approximately 100 kilometers. It is roughly spatulate in shape, reaching a maximum width of about 60 kilometers in the south. Most of the higher parts of the range, those above 600 meters, lie in this wider southern portion just below the Tropic of Cancer and north of 23° N Lat. The highest peaks apparently do not reach 1400 meters. The topography of this area is rolling and dissected, comprising a series of sharp ridges and narrow valleys with some hilly plateaus near Acuña and Santa María. Coastal plain and low mesas to the north and west separate the Sierra de Tamaulipas from the Sierra San Carlos and the Sierra Madre Oriental. On the east the coastal plain extends to the Gulf of Mexico, interrupted only by a low range of hills, the Sierra San José de las Rusias.

The Sierra de Tamaulipas is considered the southernmost of a series of low anticlinal mountains which, isolated from the main mass of the Sierra Madre and from each other, lie east of the Sierra Madre and extend north to the Sierra del Burro of northern Coahuila (Muir, 1936). The Tertiary history of these mountains is especially significant. During this period the mountains of the coastal plain are thought to have formed low islands, slowly emerging from the Eocene Sea; by Middle Eocene time, and later, they composed the eastern margin of the Mexican continent (Muir, 1936). Thus their history indicates complete geological isolation from the front ranges of the Sierra Madre Oriental.

Weather

During mid-April we recorded morning temperatures of 54° to 58° F, rising to an early afternoon maximum of 75° to 80° and falling again to 60° by nightfall. Early morning clouds which often gathered around a pine-covered ridge near our camp usually were dissipated by 10:00 a.m. On the afternoon of April 15, rising winds and falling temperatures heralded the arrival of a mild "norte" or norther which brought very heavy winds by sundown. The following morning was dark, cold, and windy with a low of 45°.

During early June we found the weather much warmer than in April, though never oppressively hot. In August, maximum-minimum readings taken at Santa María from the 6th through the 10th were as follows: high, 85° to 88°; low, 55° to 64°.

In the Sierra de Tamaulipas, as in most of northeastern Mexico, the rainy season lasts throughout the summer and autumn with the dry season beginning in early winter. At this time the trees of the tropical deciduous forest shed their leaves and remain leafless until late spring. In 1949 an unusually severe dry season resulted in a water shortage so that by early June the pools near our camp were almost the only source of drinking water for both the residents and the cattle of the Hacienda Acuña. According to Howard Reed, supervisor of the Hacienda, precipitation is heaviest during the months of August and September when torrential rains are frequent and travel is difficult. However, little rain fell during the time the Martins visited Santa María.

Vegetation

We recognize the following four major animal habitats in the Sierra de Tamaulipas:

1. Tropical Thorn Forest. Characteristic of the driest parts of the Tamaulipan Coastal Plain is a low scrub, averaging 2 to 3 meters in height. Locally it may be almost impenetrable; however, many areas are more open, grading into a savanna formation when not overgrazed. Little time was devoted to faunal studies in this habitat.

2. Tropical Deciduous Forest. This formation, analogous to Carr's Monsoon Forest (plates 25 and 26, Carr, 1950), is well developed in local areas with greater available moisture than that required by the low thorn forest. The ravines and slopes of the Sierra de Tamaulipas between 300 and 700 meters are covered by this type of dense growth in which the tallest trees attain 20 meters and a continuous canopy averages 8 meters in height. Here are found a number of Neotropical bird genera, such as *Crypturellus*, *Momotus*, *Piaya*, *Xiphorhynchus*, and *Nannorchilus*, which seldom enter other habitats in this region.

3. Montane Scrub. In certain dry areas between 600 and 900 meters, above the tropical deciduous forest, are various combinations of low thickets or savannas composed of huisache (*Acacia farnesiana*), oaks, and some trees of the tropical deciduous forest. This habitat is usually lower in height than either the tropical deciduous forest or the pine-oak woods. Near the Acuña landing strip (900 meters) thickets of this type were inhabited by *Basileuterus*

Fig. 1. Open pine woods with discontinuous crown cover. Photographed at about 1000 meters near Acuña, Tamaulipas, by William B. Heed.

rufifrons and *Toxostoma longirostre* while the more open huisache savannas were favored by *Chamaethlypis poliocephala* and *Aimophila botterii*.

4. Pine-Oak Formation. Pine and oak forests interspersed with grassland are characteristic of the Sierra above 800 meters. Our field studies were devoted mainly to this habitat. Dominant trees include *Pinus teocote*, *Quercus arizonica* (reported by Leopold, 1950), other species of *Quercus*, and hard shell hickory (*Carya* sp.). On a few slopes oak thickets and scattered live oak trees are found as low as 300 meters (near Misión), but they are infrequent at such low elevation. Within the Pine-Oak Formation there is considerable variation in development and distribution of the forest and grassland areas; many ridges and high meadows are entirely covered with short grass, others grade into either pine or oak savannas and these into woods with complete crown closure. Less than 50 per cent of the area is actually covered by woods. In only a very few wooded areas is crown cover sufficiently dense to prevent dessication of the thin ground litter. One of these excep-

tional areas was a narrow sheltered ravine near a cliff south of Acuña where moisture was conserved; here we found several species of orchids, large tank bromeliads, and jack-in-the-pulpit (*Arisaema*). The entire area of this small pocket was barely 200 square meters. Along a few ravines and stream courses vegetation was also luxuriant, maidenhair ferns were present, and here we found the Black-headed Nightingale Thrush, *Catharus mexicanus*.

Fig. 2. Pine savanna and exposed ridge at about 1100 meters near Acuña, Tamaulipas. Note low palmettos and agaves in foreground. Photographed in April, 1949, by C. Richard Robins.

Among the generally scarce shrubs, we noted a scrub palmetto and a small cycad (*Dioon* sp.). On barren ridges grow a low chamaephytic oak and a small *Agave*. In addition to bunch grass we found considerable bracken (*Pteridium aquilinum*) under the pines. As epiphytes on the oaks grew abundant Spanish moss (*Tillandsia* sp.), a member of the Crassulaceae (*Echeveria* sp.) a few orchids, and a few tank bromeliads.

Near the village of Santa María some selective pine lumbering is presently in progress.

Faunal Notes

Our mammal and bird collections are now part of the George M. Sutton Collection and the herpetological collection is at the University of Michigan. A few plants were presented to the Wiegand Herbarium of Cornell University. The majority of our collections were made in the pine-oak habitat above

800 meters and except where noted, the following faunal discussion is confined to species inhabiting the Pine-Oak Formation.

Fishes of the families Cichlidae and Characinidae were abundant in a tiny stream at Santa María and in deeper pools downstream above a 20-meter falls at Las Pilas. None were present in the pools near our camp site which contained newts (*Diemictylus*). Below these pools there was no surface drainage. About 1000 meters downstream from them was an abrupt cliff and, presumably, a waterfall in the rainy season.

Taxonomic analysis of the reptile and amphibian collections is presently in progress; most of the mammals have been discussed by Hooper (1947, 1952, 1953).

Amphibia.—*Diemictylus* sp., *Bufo horribilis, B. valliceps, Syrrhophus campi, Eleutherodactylus latrans, Hyla baudinii, Hyla* sp., *Rana pipiens.*

Lizards.—*Lepidophyma* sp. (two collected at Santa María), *Sceloporus variabilis, S. cyanogenys, S. grammicus, S. olivaceus, Cnemidolphorsu sackii, Ameiva undulata, Eumeces dicei, E. tetragrammus.*

Snakes.—*Leptotyphlops myopicus, Coniophanes imperialis, Drymarchon corais, Drymobius margaritiferus, Leptodeira annulata, Thamnophis sauritus, Micrurus fulvius.*

Turtles.—*Kinosternon herrerai* (collected from a pool near camp: identified by Norman E. Hartweg).

Mammals.—Among the mammals that we saw but did not collect were many white-tailed deer (*Odocoileus*), rabbits (*Sylvilagus*), and one peccary (*Pecari angulatus*). Coatis (*Nasua narica*) were common in remote areas away from the villages; one specimen was taken in the pine-oak woods. Tree squirrels of two species (*Sciurus aureogaster aureogaster* and *S. deppei negligens*) were common, the former in the *Tillandsia* of the oaks and hickories, the latter in the pine woods and the tropical deciduous forest. Several specimens of both were collected, including melanistic individuals of *S. aureogaster.* Small mammals trapped near Acuña included *Liomys irroratus texensis, Reithrodontomys fulvescens intermedius, Peromyscus leucopus texanus, P. pectoralis collinus, P. boylii levipes* and *Sigmodon hispidus toltecus* (Hooper 1947, 1952 and 1953).

Birds.—The following account of 72 species includes only the resident birds of the pine-oak belt: an asterisk indicates that we are uncertain whether the species so marked actually breeds in the pine-oak belt. Weights listed are in grams; fat classification follows the system of McCabe (1943). With few exceptions nomenclature follows that used in the following works: Cory, Hellmayr, and Conover, "Catalogue of Birds of the Americas"; Friedmann, Griscom, and Moore (1950); and the A.O.U. Check-list, fourth edition with supplements.

Coragyps atratus, Black Vulture. We found several large gatherings of vultures feeding on dead cattle; twenty to thirty Black Vultures came to devour a drought-killed heifer near camp.

Cathartes aura, Turkey Vulture. Seen daily, but never in as large numbers as the Black Vulture.

Buteo jamaicensis, Red-tailed Hawk. Seen occasionally in April, June, and August, indicating that they probably breed in this part of Tamaulipas.

Buteo albonotatus, Zone-tailed Hawk. Several pairs of Zone-tailed Hawks inhabited the Acuña area. One pair frequented cliffs along a ridge west of camp. On April 21, Heed and Robins discovered the nest of another pair in a pine at the foot of an escarpment overlooking a broad panorama of ridges three miles south of Acuña. This nest, constructed of twigs and oak branches and lined with fresh oak leaves, was about 40 feet above the ground and contained two whitish eggs. Friedmann, Griscom, and Moore (1950) do not list this species from Tamaulipas.

Buteo nitidus maximus, Gray Hawk. One or two noted daily, usually in the oak woods at 900 meters. On April 12, Robins secured a female with enlarged ovary (largest oocyte 6 mm.). The stomach contained three lizards, two *Cnemidophorus sackii* and a *Sceloporus*. Weight 655 grams; fat classification moderate; wing 275 mm.; tail 196 mm.

Hypomorphnus urubitinga ridgwayi, Urubitinga. Common. A nest Heed discovered April 14 in pine-oak woods was located about 40 feet above the ground in the central crotch of a tall pine. A copulating pair was observed by Robins in June. Martin saw four (a family group) at Santa María in August. A male weighing 1010 grams with testes measuring 15 × 8 mm. was taken April 12. The "flags" of this specimen are tipped with less white than those of five other Mexican *ridgwayi* examined.

**Herpetotheres cachinnans*, Laughing Falcon. Robins noted a pair near camp April 18 and 23.

**Caracara cheriway*, Caracara. Uncommon. Single birds encountered April 15 and 24; two were seen June 8.

**Falco albigularis*, Bat Falcon. Martin watched a Bat Falcon pursue several Red-crowned Parrots (*Amazona viridigenalis*) on April 13. One was seen April 18 near high rocky bluffs west of camp.

Colinus virginianus, Bob-white. Two were seen April 17 and 22; an immature female was shot from a covey of six near Santa María on August 5. In the Sierra, quail were much less abundant than in the lowlands near Gonzales and Misión. A singing male (testes enlarged) collected June 6 was identified by Dr. Aldrich of the U. S. Fish and Wildlife Service as *aridus* approaching *maculatus*.

Cyrtonyx montezumae, Harlequin Quail. Robins flushed a pair April 22 about 5 miles south of Acuña and collected the male. A pair was noted June 10 along the road to Santa María (elevation about 800 meters).

Meleagris gallopavo, Wild Turkey. Common locally on wooded hillsides about Acuña.

Columba flavirostris, Red-billed Pigeon. Noted daily in flocks of five to ten at all elevations.

Zenaida asiatica, White-winged Dove. First seen April 19 when a flock of 15 passed overhead. On April 22 Heed noted flocks of 15 to 40 doves flying low through the mountain valleys. Small groups of breeding birds present in June.

Scardafella inca, Inca Dove. A common dove in the villages of Acuña, Santa María, and in the vicinity of our camp.

Columbigallina passerina pallescens, Ground Dove. Rather common both in April and June but in small numbers, usually pairs. Measurements of two males taken in April (testes enlarging): wing, 85 and 81 mm.; weight, 37 and 35 grams.

Leptotila verreauxi angelica, White-fronted Dove. Fairly common in the thickly wooded canyon bottoms below 800 meters where they called daily. Seen less often in ravines of the dry open oak woods at higher elevations.

The ovary and oviduct of a female collected June 6 were enlarged with several oocytes measuring 6 mm.

Amazona viridigenalis, Red-crowned Parrot. Common over the high pine ridges as well as in the tropical deciduous forest of the canyons. Large flocks often flew over our camp in the evening screaming *kee-yaw, graw, graw, graw*. In mid-April we witnessed small groups engaged in erratic courtship flights accompanied by much noisy squawking. The testes of a male taken April 12 measured 14 × 7 mm.: it weighed 294 grams. We were surprised to find that this parrot is not confined to the arid tropical Tamaulipan lowlands, but ranges over the dry open pine-oak ridges with such typically temperate species as Ravens, Olive Warblers, and Red Crossbills. The crop and stomach of our single specimen contained pine seeds. At Santa María farmers shoot many parrots raiding the milpas for corn.

Coccyzus americanus americanus, Yellow-billed Cuckoo. First heard on June 5 in an oak thicket near Acuña. Three females taken June 7 and 8 were in the process of egg laying with large ruptured ovarian follicles and exposed brood patches. The oviducts of two birds each contained an ovum. Measurements resemble those of the nominate race: wing 142, 142, 148; tail, 138, 145, 149 mm. Evidently both *C. americanus* and *C. minor* breed in the Sierra de Tamaulipas although they appear to favor different habitats, *americanus* the oak thickets above 800 meters, *minor* occurring more frequently in the tropical deciduous forest below 600 meters.

Ciccaba virgata tamaulipensis, Wood Owl. Heed collected a female April 15 in a small cave in the pine-oak woods. Others called infrequently in April and nightly in early June. Largest oocyte in the ovary of our specimen measured 3 mm.; weight was 333 grams. The stomach contained beetles and the tarsus and feathers of a trogon (*Trogon elegans*).

Chordeiles minor, Nighthawk. Several observed in late April. In June six to ten hunted over our camp valley every evening and on moonlight nights we heard their booming dives at every hour from dusk to sunrise. A nest with one egg found by Heed on June 7 was located on an old path in the oak woods.

Nyctidromus albicollis yucatanensis, Pauraque. Several were calling April 9 and 12 near camp. Martin shot a female in worn plumage June 7 south of Acuña (ovary, 9 mm.; largest oocyte, 4.5 mm.; wing 163 mm.; tail 139 mm.).

**Caprimulgus salvini salvini*, Salvin's Whip-poor-will. A female collected by Robins on April 13 had enlarged ovary and little fat; it measured as follows: wing, 163 mm.; tail, 123 mm.; weight, 56 grams. In early May near Zamorina we often heard their calls; only on the night of June 3 did we hear one near camp in the Sierra.

Cynanthus latirostris latirostris, Broad-billed Hummingbird. A male was seen June 4 in open oak woods south of Acuña. Measurements of a female with unenlarged ovary taken June 7 are: wing, 53 mm.; tail, 32 mm.; culmen, 22 mm.

Amazilia cyanocephala cyanocephala, Red-billed Azure-crown. Common throughout the pine-oak and oak woods. Five females were secured; one of these, taken April 21, contained an egg (shell unformed) in the oviduct. Measurements are: wing, 59, 59, 58, 57.5, 57; tail, 34, 33, 34, 32.5, 33; culmen, 22, 21.5 (3), 21; weights of three April birds were 6.5, 6.5, and 6 grams.

Amazilia yucatanensis chalconota, Yucatan Hummingbird. Noted infrequently April 10 to 24 in the canyon bottoms. Fairly common in June in brushy thickets and in the open oaks. Our three specimens are slightly more rufous below than *chalconota* from Texas, but are much paler than *cerviniventris* of Veracruz. Weight of an April female was 4.5 grams.

Trogon elegans ambiguus, Coppery-tailed Trogon. Fairly common in the tropical deciduous forest of the canyon bottoms; less numerous in the high pine-oak woods, but

breeding in both habitats. In June Robins found a nest ten feet high in an oak. The cavity was 16 inches deep. Weights of three males collected in April were 60, 61, and 70 grams.

**Chloroceryle americana*, Green Kingfisher. One seen June 6 at a spring in a wooded ravine, elevation 1000 meters.

Piculus aeruginosus, Bronzed Woodpecker. Fairly common in the canyon bottoms below 600 meters, noted less frequently in the open pine-oak woods above 900 meters. Weight of a female with enlarged ovary taken April 12, 78 grams.

Melanerpes formicivorus formicivorus, Acorn Woodpecker. Very common in open pine-oak woods. On June 6, Martin watched an adult feeding young at a nest 25 feet high in a dead pine. The following day Robins found another nest at which at least four adults were participating in the feeding of young. Measurements of two males and two females: wing, 133.5, 130, 132, and 128 mm.; tail 77, 79, and 76 mm.; culmen 29, 27.5, 27.5, and 28 mm. Wing measurements of this series are smaller than those of three males and four females from the Sierra Madre of western Tamaulipas which range from 135 to 142 (mean 138.5 mm). Further study may justify nomenclatorial recognition of Sierra de Tamaulipas birds.

Melanerpes aurifrons aurifrons, Golden-fronted Woodpecker. On April 22 Heed collected a female, weight 73 grams, in open pine-oak woods near camp. This species is much more common in the lowlands.

Dendrocopos scalaris symplectus, Ladder-backed Woodpecker. Common through the open pine-oak hills. Several family groups noted on June 8. Wing lengths of two males and a female, 99, 102.5, and 100 mm., are characteristic of this larger subspecies rather than of the nominate form.

**Phloeoceastes guatemalensis*, Flint-billed Woodpecker. The rolling call of this large woodpecker was heard infrequently in tropical deciduous forest below 600 meters. A pair, apparently in courtship, were observed June 5. At Santa María in August several were seen on oaks (elevation 800 meters).

Lepidocolaptes affinis lignicida, Allied Woodhewer. Fairly common both in the oak parklands and in the pine-oak woods above 800 meters. On June 5, Martin discovered a nest in an open oak woods near Cerro Marquita (1000 meters), north of Acuña. The nest cavity was about ten feet above the ground in the dead vertical branch of an oak. The three white eggs present were nearly spherical and slightly smaller than those of *Trogon elegans*.

The breeding range of *L. a. lignicida* has long been cited erroneously. In southern Tamaulipas we have found this species only in cool montane forests, including both oak-sweet gum cloud forest and pine-oak forest, between 800 and 2000 meters. Sutton has collected wintering individuals along the Rio Sabinas near Gómez Farías (100 meters) in February, but *Xiphorhynchus flavigaster* is the only woodhewer known to breed in the Tamaulipan tropical lowlands. Therefore we questioned the assertion (Griscom, 1932, 1950) that the occurrence of *lignicida* ". . . in the arid hills of Tamaulipas, is one of the few cases where a Subtropical Zone bird reaches sea level in northern Mexico." In subsequent correspondence with Griscom (letter of March, 1952) we learned that this concept originated with Bangs and Penard (1919) who state that a series of eleven *lignicida* were collected by Armstrong in ". . . the very arid tropical hills of the region north and west of Ciudad Victoria." We both have examined the gazetteer of localities from which the type series was taken (Phillips, 1911) and find no positive evidence of any records below 1000 meters. The elevation given for one of the localities, Realito, is 8000 feet. The description of this area, copied

from Armstrong's field notes, clearly suggests montane humid forest. Thus the Allied Woodhewer may be considered a reasonably good indicator of cool montane forest in the northern, as well as the southern, part of its range.

A male and three females were collected. Measurements: wing 107, 105, 109, and 108 mm.; tail 93, 92, 95, and 89 mm.; weights of two females, 31 and 30 grams. Tentatively we assign our specimens to the subspecies *lignicida* although they are decidedly paler than two topotypes of that form that we have seen.

Pachyramphus major major, Black-capped Becard. Not noted until June 3 when three specimens were collected in the pine and oak woods. On June 7 a singing male was noted in oak-hickory woods near Acuña.

Tyrannus melancholicus couchii, Olive-backed Kingbird. Robins heard one April 22 and collected a male June 4 in breeding condition. Seen frequently in June and August.

Myiarchus tuberculifer lawrencei, Dusky-capped Flycatcher. Fairly common in the oak and pine-oak woods. On June 7 Robins found a nest with four or five young in a cavity 15 feet high in an oak (elevation 1000 meters). Two males taken in April weighed 21 and 22 grams.

Contopus pertinax pertinax, Jose Maria. This conspicuous flycatcher, one of the most common birds above 800 meters, inhabits pine and pine-oak woods. In mid-April they began singing before sunrise, called vigorously through the day, and often continued until long after sundown. In June and in August they sang less; more often we heard their sharp note, *bink-bink*. Although we found no nests, gonad size and courtship displays indicated that the breeding was in progress.

Four Acuña specimens are somewhat darker above than eight *C. p. pallidiventris* of Arizona and resemble more closely a series of eight specimens of *C. p. pertinax* from Chiapas in the Michigan collection. Two males and a female weighed 27 (medium fat), 20 (little fat), and 30 grams (fat).

Camptostoma imberbe imberbe, Beardless Flycatcher. Singing near Acuña in June and at Santa María in August. Measurements of a male in breeding condition taken June 7 are as follows: wing 54 mm., culmen 8.5 mm.

Corvus corax, Raven. Noted throughout the Sierra. Several pairs were in the Acuña region in April and June; others seen at Santa María in August. *Corvus ossifragus imparatus*, common throughout the Tamaulipan Coastal Plain, apparently does not enter the mountains.

Parus atricristatus atricristatus, Black-crested Titmouse. Fairly common in the Sierra as well as in the lowlands. Wing of a male measures 71 mm.; weight 15 grams.

Thryothorus ludovicianus, Carolina Wren. This Wren is fairly common locally along ravines of the oak and pine-oak woods. Dr. George Lowery in a letter to Dr. G. M. Sutton (November, 1949) identified our eight specimens as *tropicalis>berlandieri* with the following comment: "For several reasons their closest relationships appear to be with *tropicalis* rather than *berlandieri*. One example looks just like typical *tropicalis;* the lighter-backed specimens lack the rufescence of intermediates from around Victoria; and the barring of the flanks is more or less dusky in all except one bird. We might call them *tropicalis>berlandieri*, though material in fresh plumage might show that they are typical *tropicalis* rather than intermediates."

Weights of three males (April 14, 15) are as follows: 19, 19, and 17 grams; of two females (April 14), 16 and 18 grams.

**Salpinctes obsoletus*, Rock Wren. Robins recorded several April 18 on a rocky hillside west of camp.

Catherpes mexicanus mexicanus. Canyon Wren. Recorded on four days in April and twice in June, usually along cliff faces or rocky outcroppings. A pair collected April 14 weighed 18 and 17 grams.

Toxostoma longirostre, Long-billed Thrasher. One was seen near camp April 13. Martin found a nest June 7 in a brushy thicket near Acuña. The nest was four feet from the ground and contained three blue eggs marked with small russet spots. Measurements of an immature male collected at Santa María on August 6 are: wing 98, tail 128, culmen 27 mm. In size this bird matches typical *T. l. sennetti* of Texas; however, more material is needed to demonstrate whether or not intergradation in color occurs with *T. l. longirostre*.

Turdus grayi tamaulipensis, Gray's Robin. Common in small flocks in April. A nest examined June 6 was 35 feet high in a hickory at camp. A female, moderate fat, taken April 16 weighed 69 grams; a male, no fat, weighed 74 grams (April 22). Testes of this specimen were blue gray as were those of another male shot March 1 near Gómez Farías.

Myadestes obscurus, Brown-backed Solitaire. Uncommon, several birds were heard frequently in ravines near camp.

Catharus mexicanus mexicanus, Black-headed Nightingale-Thrush. Although no *Catharus* were recorded in April, this birds was one of the first species we encountered upon returning to our camp site June 3. They sang daily from humid ravines among the pine-oak woods for the remainder of our stay and were in song at Santa María in August. One spotted immature was noted near Santa María on August 10. *Catharus mexicanus* is much more common in the Rancho del Cielo cloud forest near Gómez Farías. Four males with enlarged testes and a female with a large oocyte (8 × 7 mm.) were collected.

Sialia sialis, Bluebird. Fairly common, especially about the settlement of Acuña. On June 2 a bluebird was observed carrying food. Two juveniles were collected June 8 near camp. Measurements: two males, wing 99, 95; tail 67, 62; two females, wing 93, 96; tail 59, 60.

Poliopotila caerulea deppei, Blue-gray Gnatcatcher. Fairly common in April and, locally, in June south of Acuña. Three birds in breeding condition were secured. Measurements of these are: two males, wing 48.5, 46; tail 52, 47 mm.; one female, wing 47; tail 44.5 mm.

Vireo griseus micrus, White-eyed Vireo. Martin heard songs of this species south of Acuña on April 20. Wing of a male collected there on June 7 measured 58 mm.

Vireo huttoni mexicanus, Hutton's Vireo. Common in the pine-oak woods. Singing constantly in April and June. Heed watched a pair constructing a nest of Spanish moss 20 feet up in an oak. Five males, all with testes slightly enlarged, were collected. Wings measured 63, 64, 66 (3); weights of two were 11 and 12 grams.

Vireo olivaceus flavoviridis, Yellow-green Vireo. One pair noted April 23. Abundant in June both in the tropical deciduous forest and in the pine-oak woods to 1000 meters. Robins found a nest with four white eggs at camp June 9, 25 feet high in an oak. The oviduct of a female shot June 5 contained two eggs.

Vermivora superciliosa mexicana, Hartlaub's Warbler. Common. Noted daily on the open oak and pine-oak hillsides, usually in company with the equally common Pitiayumi warbler. Three birds collected April 15 and 22 were approaching breeding condition. Two of these (a male and a female) each weighed 9 grams.

Parula pitiayumi nigrilora, Pitiayumi Warbler. One of the most common birds in the Acuña region. Their wiry buzz could be heard through the pine-oak parklands as well as in the dense tropical deciduous forest of the canyon bottoms. Measurements of a male and two females are as follows: wing 54.5. 50, 49; tail 40, 38, and 36 mm.; weights 8, 7, and 7 grams.

Peucedramus taeniatus arizonae, Olive Warbler. In the pine and oak woods of the ridges we discovered this inconspicuous warbler. Robins collected what he thought was a copulating pair on April 17, but discovered upon preparing the specimens that the ovary of the female (very fat) was just enlarging. Testes of adult April males were enlarged with the seminal vesicles present; those of a one-year old male taken June 6 were only slightly enlarged. Weights of April males were 10, 12, and 12 grams; two females weighed 11 and 12 grams.

Our six Acuña birds are similar to the subspecies *arizonae*: they lack the olivaceous wash on the back and the broad yellow edging of the secondaries said to be typical of *giraudi* and are much duller on the throat and crown than *taeniatus*. Indeed the narrow lemon yellow edging of the secondaries is reduced to such an extent that we could separate our five adults from 25 *arizonae* males and 14 spring *arizonae* females on this feature alone.

Chamaethlypis poliocephala poliocephala, Thick-billed Ground-Chat. This shy bird of the scrub oak and huisache was common locally in April and June. The song, usually given from a low shrub, is a hurried *zip zip zip zip wichy wichy wichy*. Two specimens, both males, were collected.

Basileuterus rufifrons jouyi, Rufous-capped Warbler. Noted frequently in April and June; gonads of June specimens were enlarged. Brushy slopes of the montane scrub above 600 meters appeared to be their favorite habitat.

Tangavius aeneus aeneus, Red-eyed Cowbird. First recorded April 19, seen daily thereafter.

Cassidix mexicanus prosopidicola, Great-tailed Grackle. A female (weight 108 grams) was shot from a flock of five near camp April 12, elevation 1000 meters. Several were recorded April 16. This species is much more common in the lowlands. Our specimen is darker below and smaller than *C. m. mexicanus*.

Icterus graduacauda graduacauda, Black-headed Oriole. Common in the tropical deciduous forest as well as in the higher, open pine-oak woods. Measurements of three males and a female are as follows: wing 99, 94, 100, and 88; tail 95, 97, 101, and 92.5; weights 46, 48, 40, and 40 grams.

Icterus cucullatus cucullatus, Hooded Oriole. Several seen in the low scrub *Acacia* near Acuña April 19-21. Two males taken June 3 and 4 were in breeding condition. Measurements of three males: wing 87, 88, 85 mm.; tail 97, 95, 91 mm.; weight of one male (April 20), 26 grams.

Tanagra elegantissima elegantissima, Blue-hooded Euphonia. Heed shot a singing male in open pine-oak country south of camp June 4 (testes enlarged, brood patch present, no fat), but we failed to find others. *Tanagra affinis* and *T. lauta* occur in the tropical deciduous forest, but did not appear at higher elevations in the breeding season.

Piranga flaxa dextra, Hepatic Tanager. One of the most common birds of the Acuña region. In April groups of five to ten frequently were seen feeding on the ground along the open grassy ridges. On June 9 Robins found a nest seven feet high

in a small oak on a pine-oak hillside. The nest, a loose structure of twigs placed near the end of a small branch, contained three young about ten days old. Weights of an adult male and two females are 45, 38, and 40; of an immature male, 35 grams.

Piranga bidentata sanguinolenta, Flame-colored Tanager. Fairly common in the canyons and noted infrequently in the pine-oak woods. Ovaries of two females collected April 14 and 15 were enlarging; weights were 32 and 34 grams. A singing male shot June 5 was in breeding condition.

**Rhodothraupis celaeno*, Crimson-collared Grosbeak. Found mainly in the canyons below 600 meters and in the thorny thickets of the lowlands, although a small group was seen in an open oak woods four miles south of Acuña on April 9 (elevation 900 meters).

Guiraca caerulea interfusa, Blue Grosbeak. Fairly common at Acuña in April where flocks could always be seen in the fields. In June they were scattered, singing and paired. Common about the milpas at Santa María.

Sporophila torqueola, Ringed Seedeater. Common. Three males collected are not in full adult plumage so we are uncertain of the subspecies. At Santa María in August Martin saw several adult males with what appeared to be complete dark chest-bands, typical of *S. t. morelleti*.

Spinus psaltria psaltria, Arkansas Goldfinch. Small groups fairly common in the open pine-oaks in April. They were paired and singing commonly throughout the region in June. Very common about the village of Santa María. Measurements of two males are: wing 61 and 62 mm.; tail 40 and 42; weight of one 9.5 grams.

**Loxia curvirostra stricklandi*, Red Crossbill. Fairly common above 900 meters. Flocks of four to fifteen were noted near camp every day feeding in the pines. Four immature birds were taken (April 10 and June 6) along with ten adults; however, we found no evidence of nesting and gonads of all adults were small. No crossbills appeared at Santa María in August. Although our birds are smaller in wing measurements (average of five males 95.4 mm.) than typical *stricklandi*, the depth of the bill (average 12 mm.) and brick red underparts indicate this subspecies. Weights of three males: 40, 40, and 39 grams; of three females: 35, 38, and 40 grams.

Aimophila ruficeps boucardi, Rock Sparrow. Fairly abundant throughout the pine and pine-oak woods, favoring especially fallen trees, clumps of cycads, and any brush available for cover in the open woods. Young birds seen flying June 6 to 10.

Fourteen specimens were collected in all; those taken in August are too worn to be of value for measurements. Critical examination reveals differences in size and color between our specimens and typical *boucardi* from the Sierra Madre Oriental of Nuevo Leon. However, the differences are not outstanding and further study is necessary to determine whether this population warrants subspecific status. Measurements of five males and four females are: wing of males 61–63 (62), females 56–58 (57.1); tail of males 58–65 (62.6), females 58–62 (60); weights of five adults: 19, 21, 20, 22, and 20 grams.

Aimophila botterii, Botteri's Sparrow. On April 19, Robins shot a male in a burned-over section of the Canyon de las Animas. *A. botterii* was not recorded again until June 7 when several birds in breeding condition were collected in open *Acacia* and brushy fields south of Acuña (900 meters). On June 10 Heed and Martin noted numerous Botteri's Sparrows in thorn forest and savanna near Agua Fria (100 meters). Measurements of six males and two females are as follows: wing of males, 63–68 (65), females, 61 and 63 (62); tail of males, 62–66 (64), females, 57 and 64 (60.5).

Vegetation of the Pine-Oak Formation

In the Sierra Madre Oriental of Tamaulipas two climatically and physiognomically distinct types of oak-pine forest can be recognized, as follows:

1. An arid phase with widely spaced trees, the oaks generally round-crowned with gnarled branches, the pines of medium height, seldom exceeding 25 meters. The flora is often characterized by *Agave americana, Pteridium, Juniperus, Juglans, Arbutus,* and a wealth of grasses. The western slopes of the Sierra Madre Oriental around La Joya de Salas and Carabanchel and the drier portions of the eastern side are covered by this park-like woodland which is quite similar to the pine-oak belt of the coastal plain Sierras. In Novilla Canyon west of Ciudad Victoria and along the Dulces Nombres road west of El Barretal arid pine-oak woods with associated palms (*Sabal*) and chamal (*Dioon*) descend to less than 700 meters where they contact thorny scrub forest of the lowlands. This arid pine-oak woods is probably homologous to Muller's Montane Low Forest of Nuevo Leon and Coahuila (1939, 1947), characterized by a mild and semi-arid climate.

2. Humid pine-oak forests of tall, straight, closely spaced and narrow crowned trees which often reach 30 meters are a feature of more mesic portions of the Sierra Madre east of La Joya de Salas. A wealth of large tank bromeliads and other epiphytes, numerous ferns, selaginellas, and mosses appear here. Fir (*Abies*), yew (*Taxus*), *Tilia, Cupressus, Garrya, Cornus,* and *Myrica* are some of the associates of *Pinus patula, P. montezumae,* and the various oaks which comprise the dominant species.

Apparently the coastal plain Sierras are too dry to support this mesic type forest which is confined largely to higher parts of the Sierra Madre above 1500 meters on the eastern slope and 2000 meters or more on the western side. In Nuevo Leon and Coahuila, Muller (*op. cit.*) describes a Montane Mesic Forest with a cool, sub-humid climate. This appears quite similar in physiognomy to, and only slightly different in flora from, the humid pine-oak forest of Tamaulipas.

Despite certain floristic differences, the pine-oak belt of the Sierra de Tamaulipas is clearly the climatic equivalent of the arid pine-oak woods or Montane Low Forest of the Sierra Madre Oriental. Evidently the pine-oak belt of the Sierra San Carlos is also arid. In view of this physiognomic and climatic similarity, the coastal plain Sierras may be expected to exhibit a close faunal relationship to the arid pine-oak formation found along most of the Sierra Madre.

Fauna of the Pine-Oak Formation

1. Birds. Throughout the Mexican Plateau certain characteristic species can be expected wherever pine-oak forests are found, including the following:

TABLE 1

Birds Largely Restricted to Pine-Oak Communities in Tamaulipas

A. Species found both in the Sierra Madre Oriental and Sierra de Tamaulipas.	B. Species found only in the Sierra Madre Oriental.
Buteo albonotatus	*Columba fasciata*
Cyrtonyx montezumae	*Glaucidium gnoma*
Melanerpes formicivorus[1]	*Hylocharis leucotis*
Lepidocolaptes affinis[1-2]	*Eugenes fulgens*
Pachyramphus major[1]	*Trogon mexicanus*[1]
Myiarchus tuberculifer[2]	*Dendrocopos villosus*
Contopus pertinax[2]	*Empidonax difficilis*
Corvus corax	*Mitrephanes phaeocercus*[2]
Catherpes mexicanus[1-2]	*Aphelocoma ultramarina*
Myadestes obscurus[1-2]	*Parus wollweberi*
Catharus mexicanus[1-2]	*Troglodytes brunneicollis*
Vireo huttoni	*Melanotis caerulescens*[1-2]
Vermivora superciliosa[1]	*Catharus aurantiirostris*
Peucedramus taeniatus	*Catharus occidentalis*[2]
Basileuterus rufifrons[2]	*Sialia mexicana*
Tanagra elegantissima	*Ptilogonys cinereus*
Piranga flava	*Setophaga picta*
Piranga bidentata[1-2]	*Basileuterus belli*
Aimophila ruficeps	*Pheucticus melanocephalus*
Loxia curvirostra	*Hesperiphona abeillei*[1-2]
	Atlapetes pileatus
	Aimophila rufescens

1. Also nests in oak-sweet gum cloud forest (Harrell, MS).
2. Winters below 300 meters in the tropical lowlands.

Columba fasciata, Trogon mexicanus, Dendrocopos villosus, Melanerpes formicivorus, Contopus pertinax, Aphelocoma ultramarina, Troglodytes brunneicollis, Catharus occidentalis, Sialia mexicana, Peucedramus taeniatus, Pheucticus melanocephalus, and *Atlapetes pileatus.* In the Sierra Madre Oriental of Tamaulipas we found 44 species which are largely confined to the pine-oak formation at least at its lower limit (Table 1). Some of these such as *Parus wollweberi, Setophaga picta,* and *Aimophila ruficeps* apparently favor arid pine-oak woods, while others including *Trogon mexicanus, Catharus occidentalis,* and *Hesperiphona abeillei* inhabit the humid or Montane Mesic Forest. However, it would be premature to attempt a subdivision of the pine-oak avifauna into species favoring arid or humid communities; actually many forms range throughout both.

In the Sierra de Tamaulipas 20 of the 44 Sierra Madre species were found (Table 1, List A). Most of these are typical of arid woods in the Sierra Madre, although a few, such as *Lepidocolaptes affinis* and *Catharus mexicanus*, are not. We conclude that the pine-oak avifaunal component of the Sierra de Tamaulipas exhibits a strong relationship to that of the Sierra Madre despite the relatively small area and homogeneous nature of the pine-oak habitat in the former.

2. Mammals. Obviously our knowledge of the mammal fauna is meager; however, all the species recorded thus far, with the exception of *Peromyscus boylii*, are known to occur in the foothills or lowlands below the pine-oak belt. *P. boylii* is also the only species listed by Dice (1937) which might be confined to the pine-oak belt of the Sierra San Carlos.

3. Reptiles and amphibians. In contrast to the pattern of bird distribution the herpetological affinities of the Sierra de Tamaulipas are almost entirely with the lowlands. Admittedly our faunal sample is incomplete; nevertheless of the 25 species recorded, all but *Lepidophyma* and possibly *Eumeces dicei* range below the pine-oak belt, most of them occurring throughout the arid lowland scrub of northeastern Mexico. Of the entire group only *Eumeces dicei* is definitely disjunct in its zonal distribution, having been taken at 500 meters in the Sierra San Carlos, at about 900 meters in the Sierra de Tamaulipas, between 1100 and 2000 meters in the Sierra Madre near La Joya de Salas, and at 600 meters near Ciudad Victoria. It is especially significant that the highly diverse iguanid genus *Sceloporus* is represented in the Sierra de Tamaulipas by four species which are typical inhabitants of the lowlands, while those species abundant in the Sierra Madre near La Joya de Salas such as *S. torquatus*, *S. jarrovii*, *S. parvus*, and *S. scalaris* were not collected. Thus it appears that the mammals, reptiles, and amphibians exhibit very slight relationship to the pine-oak faunal component of the Sierra Madre.

Reptiles and amphibians reported from the Sierra San Carlos (Gaige, 1937) were taken mainly below the pine-oak belt. Virtually all of the species listed also inhabit the Tamaulipan lowlands; no forms restricted to the pine-oak formation were collected.

Discussion

Pollen studies correlated with archeological horizons from the vicinity of Mexico City (Sears, 1952) have thrown new light on the problem of Pleistocene climatic fluctuations far below the continental glacial border, and remove some of the burden of proof from evidence based on relict distributions alone. Evidence for the extreme views adopted by some that during the period of maximum refrigeration the South American faunal element was virtually destroyed in Mexico (Griscom, 1950) and the Tropical Zone was driven into a narrow coastal fringe in Central America (Beecher, 1950) is

largely circumstantial; but the more substantial data afforded by fossil records and relict mammal distribution patterns (Burt, 1949) suggests a definite refrigeration of climate in Mexico.

Although fossil evidence from the coastal plain of Mexico is lacking, we suspect that significant fluctuations of climate and vegetation occurred. In view of the pollen findings of Potzger and Tharp (1947) from Austin, Texas, which demonstrate major changes in the vegetation of that area, 500 miles north of the Sierra de Tamaulipas, it seems probable that northeastern Mexico was also affected. A climatic shift sufficient to lower the present arid pine-oak belt with its mild, semi-arid climate from the 700 to the 200 meter contour would establish habitat continuity between the Sierra Madre and the coastal plain ranges. At such a time faunal movement across the coastal plain would have been possible for species inhabiting the pine-oak belt.

Assuming then that faunal isolation in the Sierra de Tamaulipas is of post-Wisconsin age, we must account for the absence of a distinct pine-oak faunal component among the terrestrial vertebrates. Why are the relationships of the mammals, reptiles, and amphibians almost exclusively with the lowlands in contrast to the strong montane affinities of a third of the breeding birds? We offer the following two hypotheses:

1. Small habitat size. As previously mentioned, the pine-oak formation of the Sierra de Tamaulipas occupies a small area; it may cover less than 700 square kilometers. Optimal population conditions are not realized by animals restricted to small isolated habitats and the possibility of local extermination of species confined to this formation is much greater than for the same species inhabiting the extensive pine-oak belt of the Sierra Madre Oriental. Among the vertebrates, the birds, with their superior dispersal capacity, should be able to maintain balanced populations by occasional immigration from the Sierra Madre.

2. Post-glacial thermal maximum. In view of the xeric-mesic fluctuations dating to at least 2000 B.C. in the Valley of Mexico (Sears, 1952), and the xerothermic intervals postulated on the basis of pollen studies in eastern North America (Sears, 1948), it is probable that in recent times the pine-oak formation of the Sierra de Tamaulipas was somewhat constricted. If xerothermic conditions did prevail here, a retreat of the pine-oak woods to isolated peaks and north-facing ravines would follow, subdividing the habitat into numerous isolated pockets. Under such conditions animals confined to the pine-oak belt would be in danger both of increased competition from invading lowland species and local extirpation in an environment too small to support adequate breeding populations. As the habitat increased again under the return of favorable climatic conditions, only the birds succeeded in re-establishing part of the Sierra Madre faunal element.

Summary

Isolated from the main front of the Sierra Madre Oriental, the Sierra de Tamaulipas is surrounded by xeric thorny scrub of the Gulf Coastal Plain. A belt of arid pine-oak woods covering its higher slopes forms an environmental island of temperate forest for certain animals which reached this habitat from the Sierra Madre. Of 44 birds largely confined to pine-oak forests in the former, 20 were also found in the Sierra de Tamaulipas; however, virtually none of the amphibia, reptiles, or mammals restricted to this habitat in the Sierra Madre appeared in the Sierra de Tamaulipas.

On the assumption of Pleistocene connection between the pine-oak belts of the two Sierras, we postulate both small habitat size and a post-glacial xerothermic effect as responsible for the observed faunal composition of the Sierra de Tamaulipas.

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